Path 2 Dispatchable Power Systems Overview

Dispatchable Solar Power Systems are …

Parabolic Trough & Power Tower Systems

- **Distributed to Bulk Power (100 kW to 200 MWe)**
- **Low to Moderate Risk Solar Technology**
- **Conventional Power Plant Technologies**
- **Able to dispatch power via hybridization or thermal storage**

Dispatchable Systems Deliver Power … When It's Needed!

Concentrating Solar Power
Sun♦Lab
Sandia National Laboratories, Albuquerque, NM
National Renewable Energy Laboratory, Golden CO

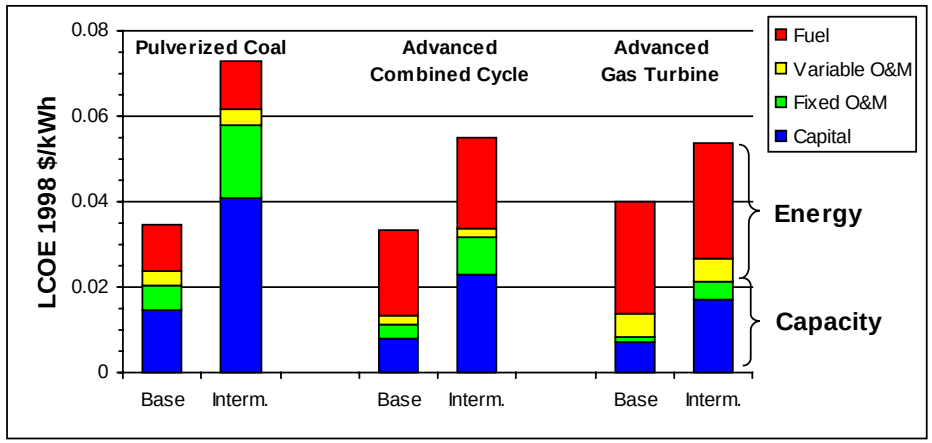
Path 2 Dispatchable Power Systems Overview

Parabolic Trough & Power Tower Systems:

- **Lowest cost solar power option**
- Wide range in application size
- Potential for rapid production scale-up
- Opportunities for continued improvement in cost, performance, reliability

Path 2 Dispatchable Power Systems Overview

Levelized Cost of Electricity for Large-scale Conventional Technologies



Value of Dispatchable Solar Power (System) ~ 5.5 ¢/kWh

Based on 1999 Fuel Pricing
< $2 MMBtu Natural Gas

Value of Power from Renewable Technologies

Technology	Dispatchable	Correlation with System Load	Value of Power Produced ¢/kWh	Power Technology Offset	Type of Payments
Dispatchable CSP*	Yes	Good	5.5	Combined Cycle	Energy & Capacity
Large scale PV w/o TES	No	Good	2.3	Combined Cycle	Energy
Wind	No	Poor	1.4 – 2.3	Coal & CC	Energy
Geothermal Biomass	Yes	Baseload	3.5	Coal & CC	Energy & Capacity

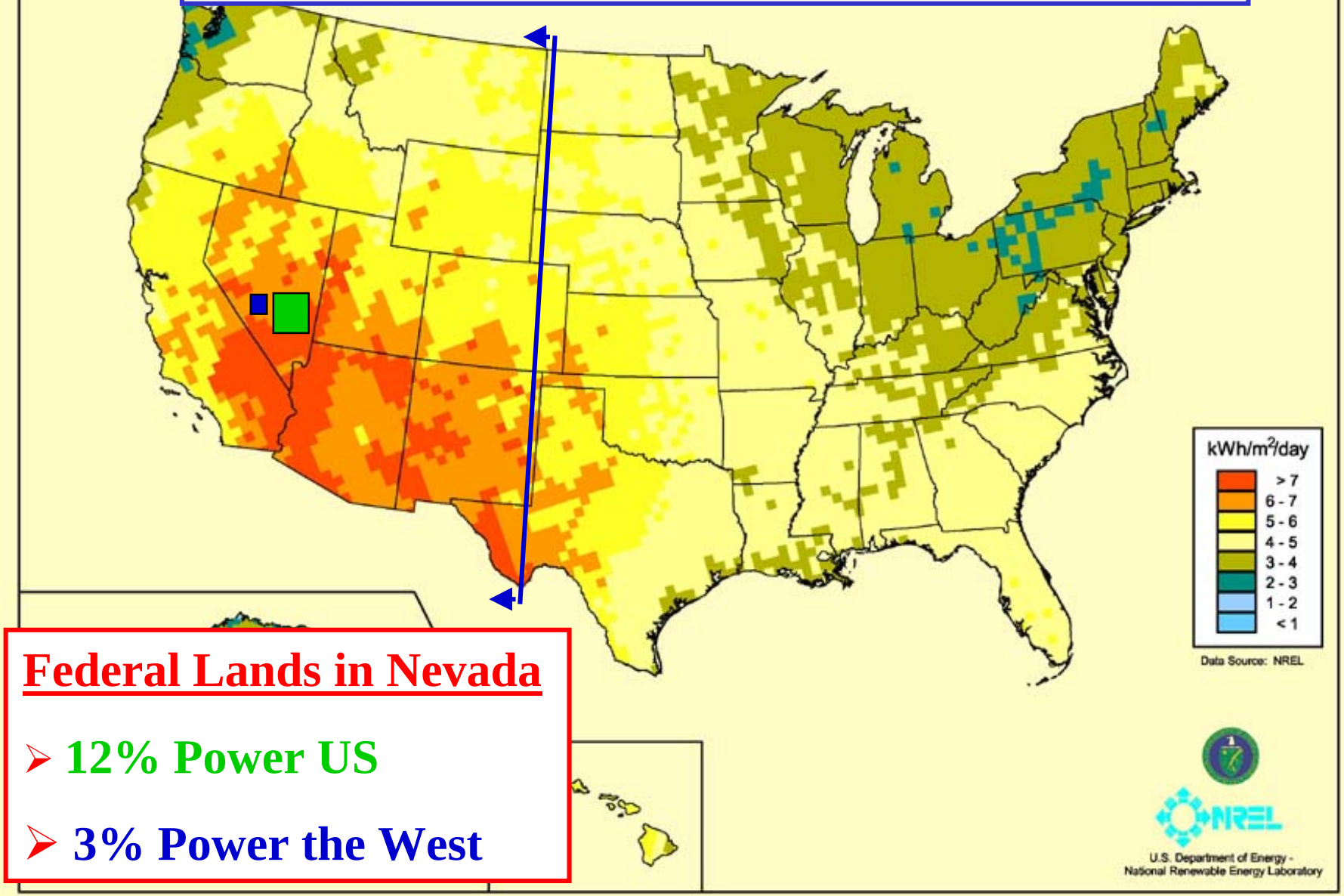
Path 2 Dispatchable Power Systems Overview

- Value of Dispatchable Solar
  - Energy/Capacity 5.5 ¢/kWh
  - Green Value 3¢/kWh *(RDI based on wind experience)*

- Where is dispatchable the technology
  - Current prices paid to SEGS 10-14 ¢/kWh
  - Next Trough Plants 12-14 ¢/kWh
  - Near-term ~8 ¢/kWh *(4^{th} plant)*

Diablo Canyon (Nuclear) greater than 10 ¢/kWh (prior to restructuring)

Why are Tower and Trough CSP Technologies Important?



Federal Lands in Nevada

- **12% Power US**
- **3% Power the West**

Path 2 Dispatchable Power Systems Overview

Technical Status

Parabolic Trough

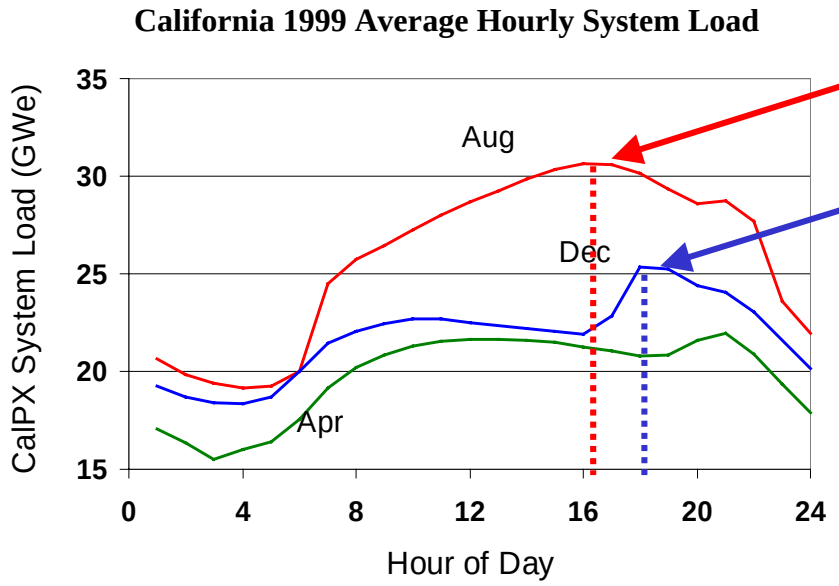
- Commercially demonstrated
- Low technology and cost risk
- Currently lowest cost near-term solar technology option
- Significant opportunity for improvement

Power Towers

- Pre-commercial demonstration
- Moderate technology risk
- Moderate cost uncertainty
- Future advanced technology option

Path 2 Dispatchable Power Systems Overview

Why is dispatchability important?



Price of Power (RDI Analysis)

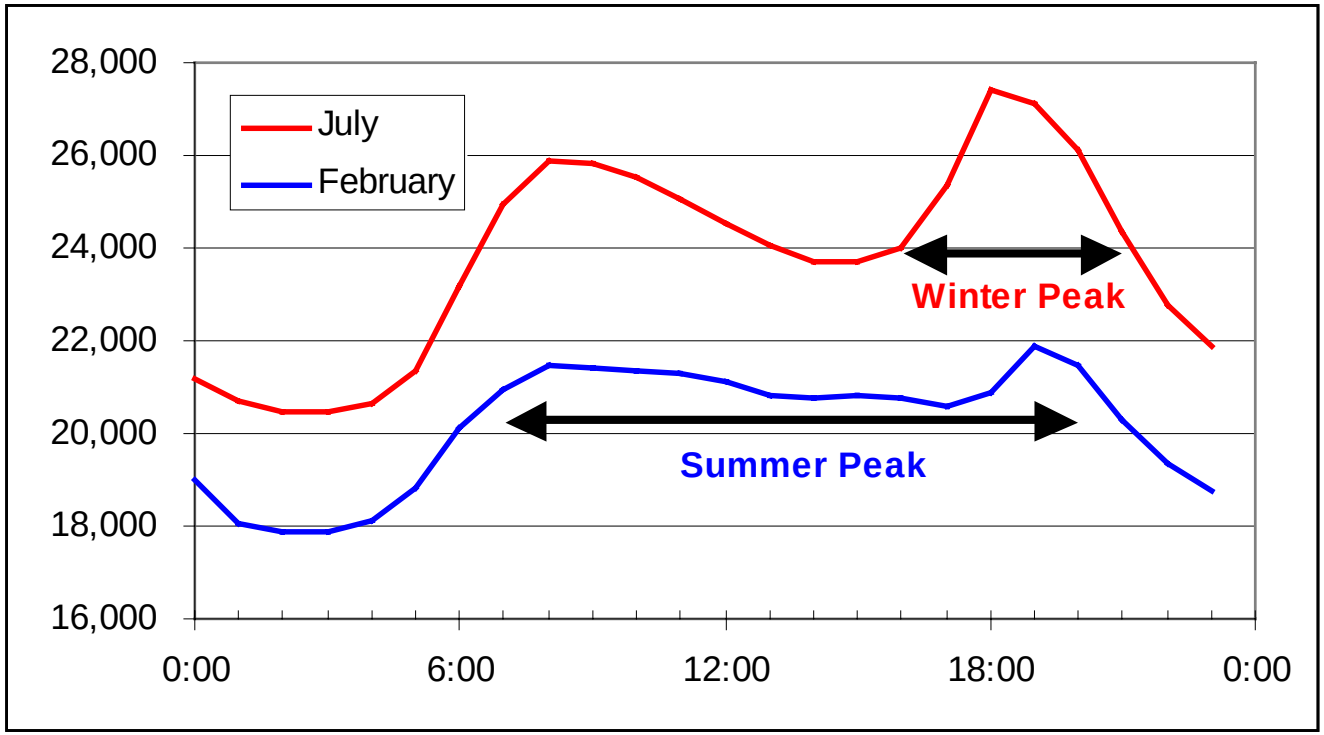
• Average	4.3 ¢/kWh
• Hybrid Solar	6.0 ¢/kWh
• Solar w/Storage	6.0 ¢/kWh

Make power when:

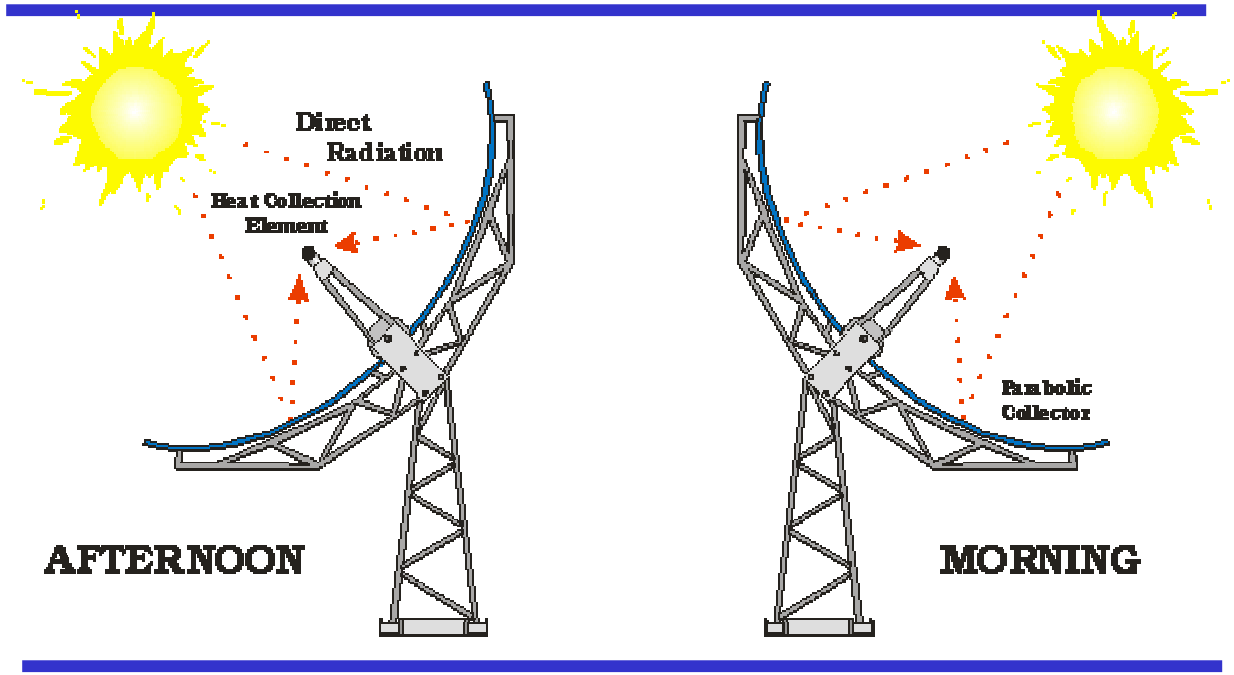
- **It's needed!**
- **It has the highest value!**

Path 2 Dispatchable Power Systems Overview

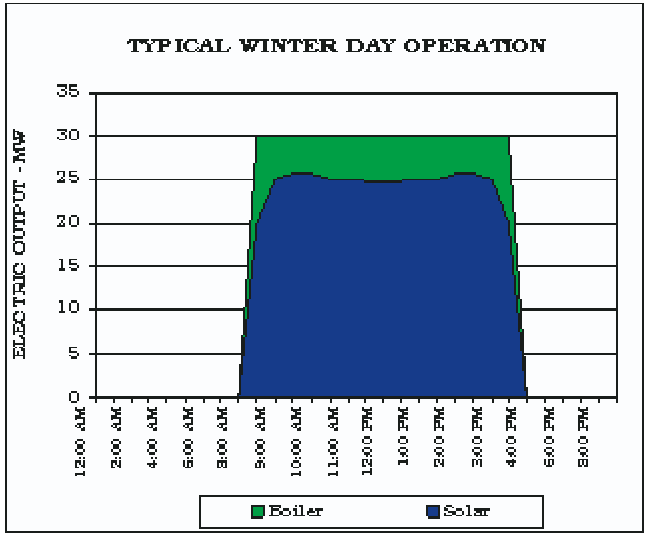
Eskom Load Profile

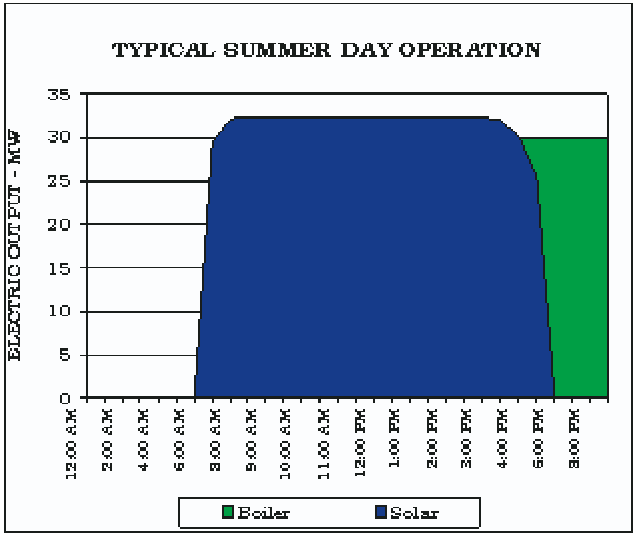


Simple Schematic of Parabolic Trough Operation (North-South Axis)



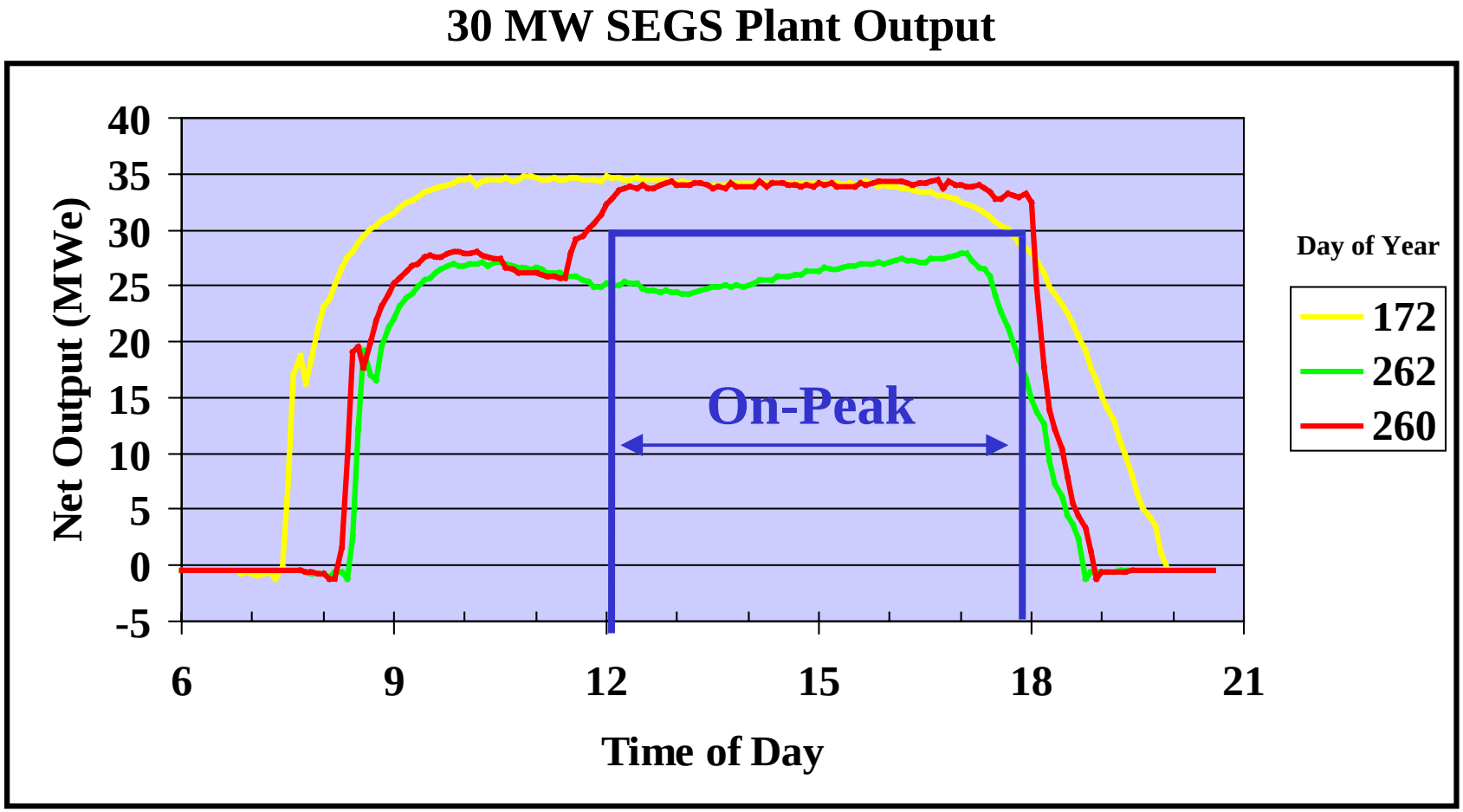
Modes of Operation



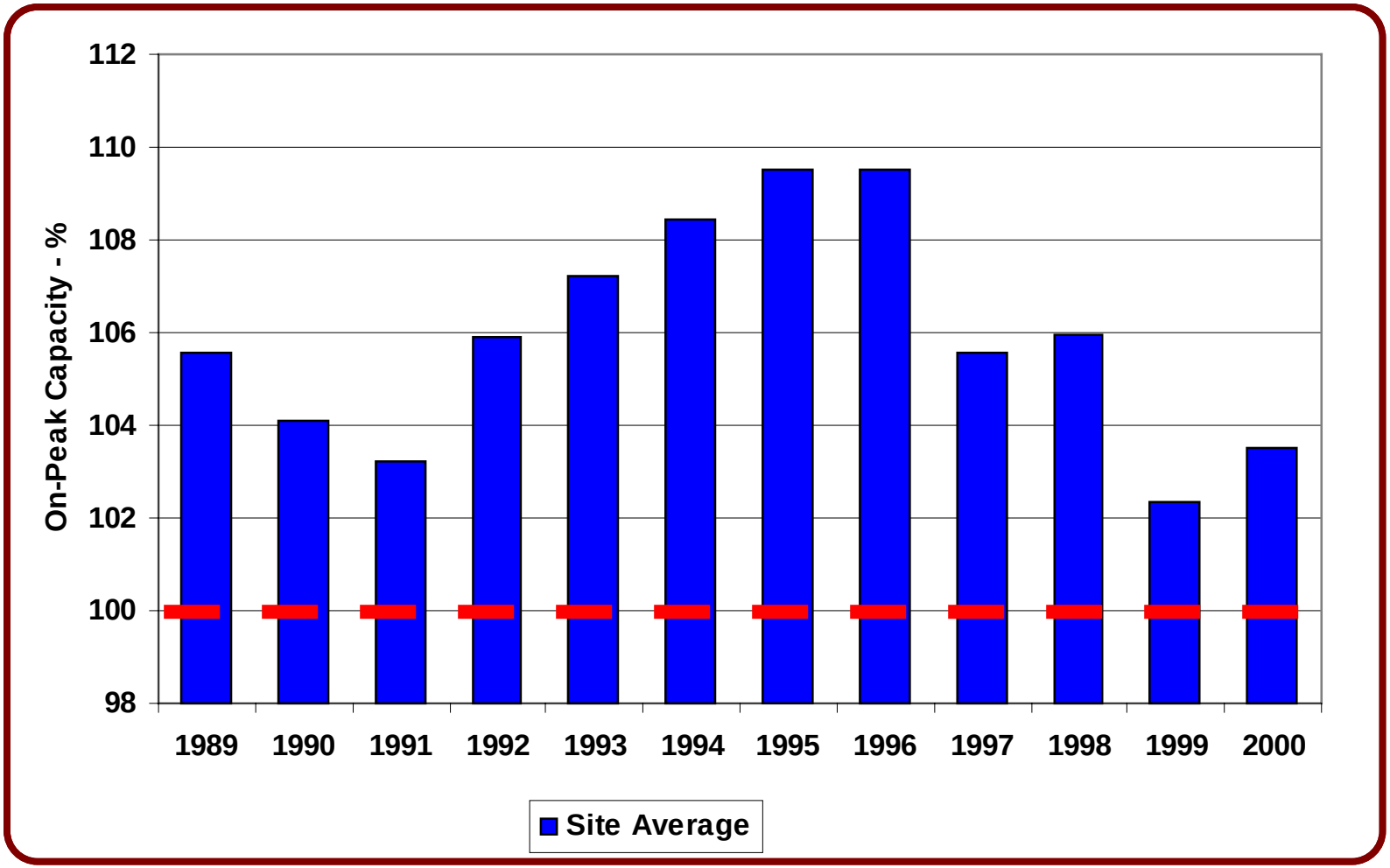


kjc OPERATING COMPANY

Path 2 Dispatchable Power Systems Overview



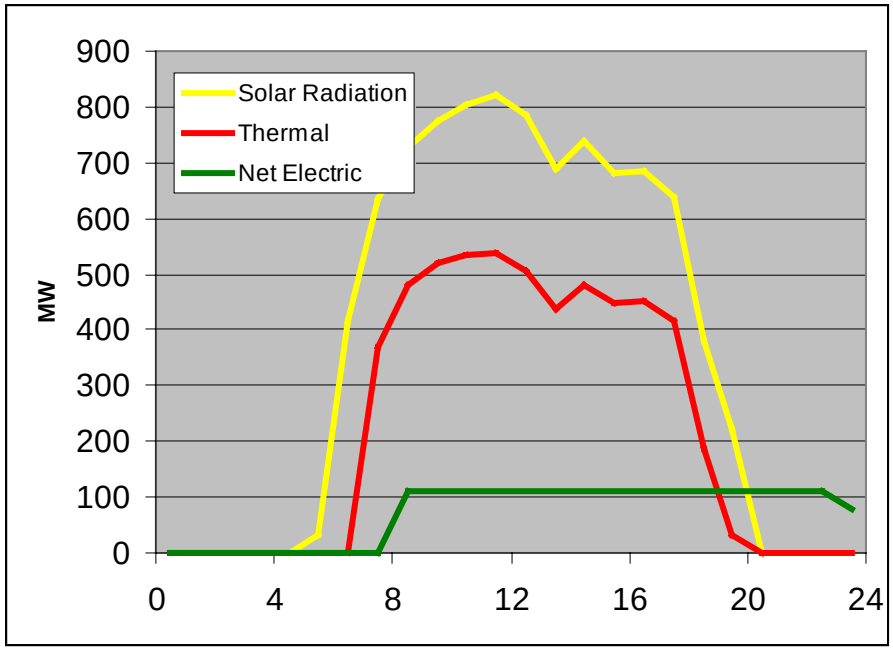
Kramer Junction SEGS Peak Capacity



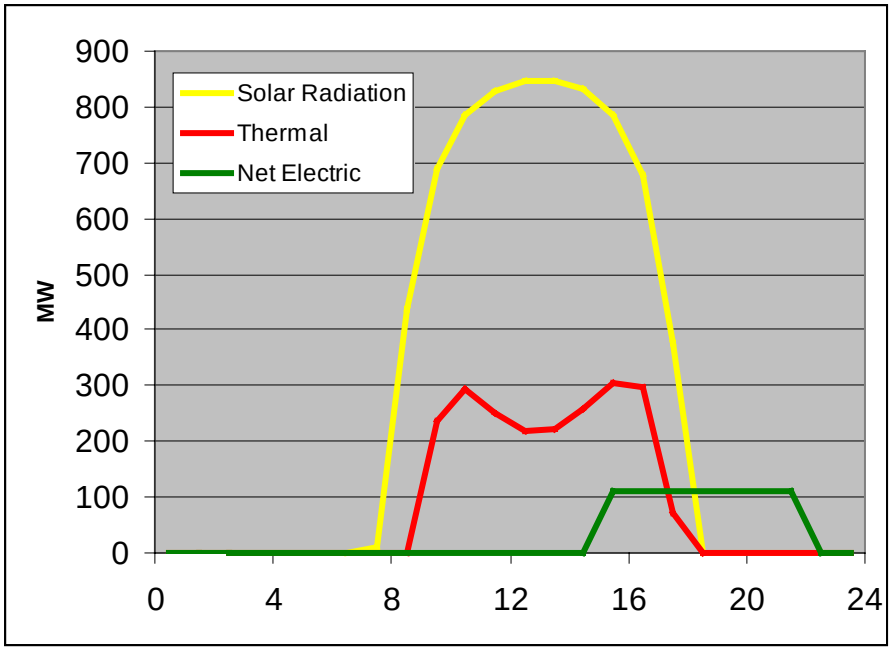
Path 2 Dispatchable Power Systems Overview

Power Dispatch for Trough Plant with Thermal Storage

Summer



Winter



100 MW Trough Plant
1.8 Solar Multiple
6 hours Thermal Storage

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Path 2 Dispatchable Power Systems Overview

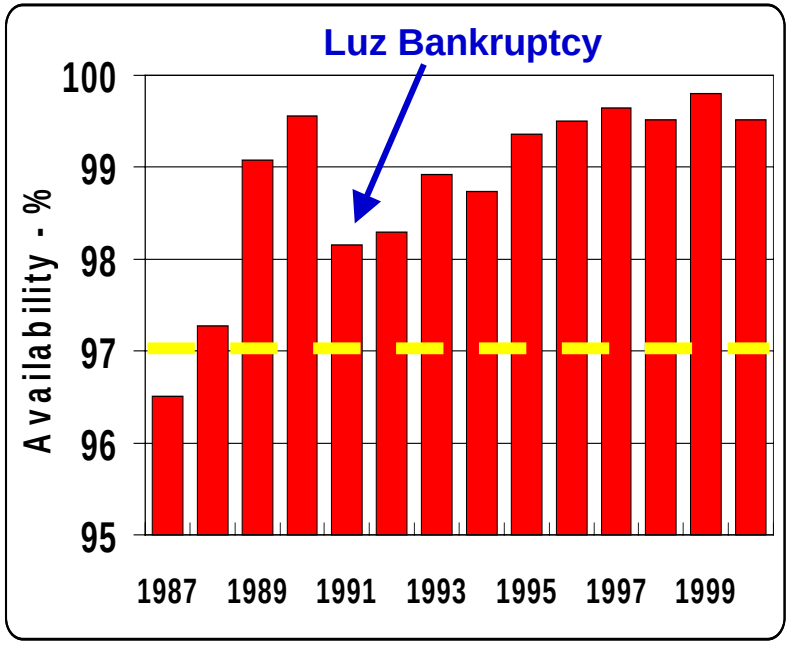
Meeting Peak Hour Demand (Full Year)

	Peak Capacity Factor	
Wind	25%	**CEC Report**
Solar w/o Storage	36%	
Solar w/ Storage	87% - 102%	
Hybrid Solar	>100%	**KJ SEGS Experience**

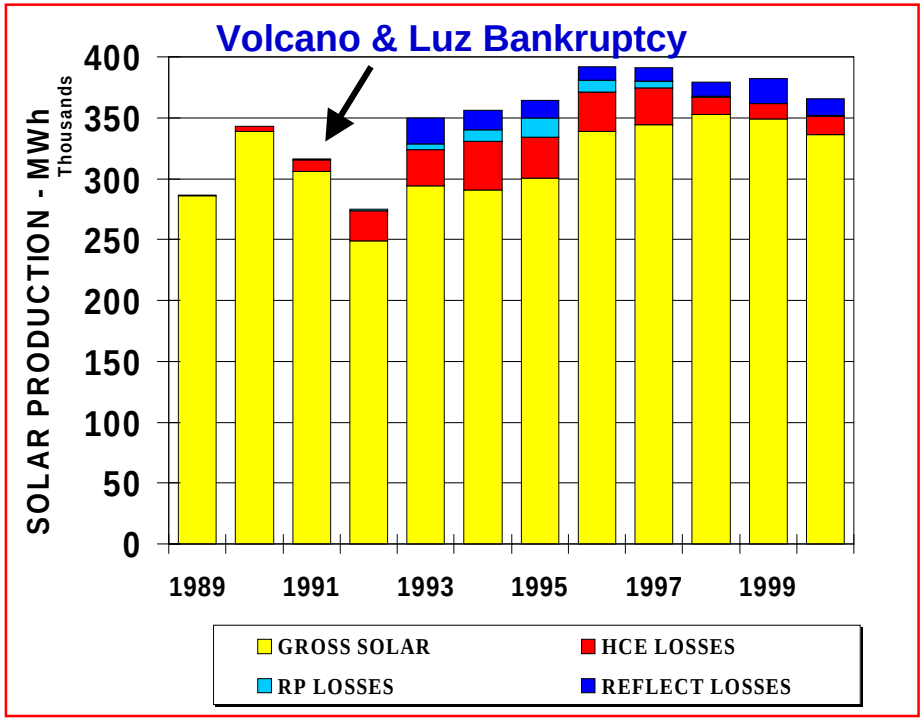
Path 2 Dispatchable Power Systems Overview

Trough Technology
Stellar Performance Record

Solar Field Availability



Solar Electric Generation



Path 2 Dispatchable Power Systems Overview

Parabolic Trough/Accomplishments

- Nine Commercial Plants in U.S.
  - Over 1.2 Billion in commercial financing
- 126 plant years (1st plant in 17th year of Operation)
- Generated > 9,000,000,000 Solar kWhrs
- Demonstrated Dispatchable Operation
  - SEGS I – Thermal Storage
  - SEGS II-IX – Fossil Hybrid
- Technology continues to be improved

Path 2 Dispatchable Power Systems Overview

Trough Technology

– CSP Trough Program Overview	Hank Price
– Trough Solar Technology R&D	Rod Mahoney
– Trough Thermal Storage R&D	Jim Pacheco
– Power Cycle Integration R&D	David Kearney
– Trough Industry	John Myles

Tower Technology

– Tower R&D	Hugh Reilly
– Solar Tres	Bill Gould